

Notice of Intent and Request for Information Regarding Establishment of a Program to Use Defense Production Act to Support Electric Heat Pump Manufacturing and Deployment

American Council for an Energy Efficient Economy (ACEEE)

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About ACEEE

The American Council for an Energy-Efficient Economy (ACEEE) is a nonprofit research organization that develops transformative policies to reduce energy waste and combat climate change. With our independent analysis, we aim to build a vibrant and equitable economy—one that uses energy more productively, reduces costs, protects the environment, and promotes the health, safety, and well-being of everyone. ACEEE has been a leader for over three decades in industrial energy policy, programs, and technologies. The comments below highlight key findings gathered by ACEEE staff who have researched industrial heat pumps (IHPs), focusing specifically on their potential to electrify industrial process heat as a means to reduce GHG emissions and energy use.

Introductory Remarks

Heat pumps have the potential to significantly accelerate decarbonization of the industrial sector through the electrification of process heating and cooling. While heat pump technologies for residential and commercial uses have received some attention, the potential use of heat pumps in industry—and the associated energy and greenhouse gas (GHG) savings—is underappreciated and underexplored. Industrial process heat accounts for as much as 51% of on-site industrial energy use. Across all manufacturing, process heating is responsible for almost 300 million metric tons of onsite CO₂e emissions. Electricity currently provides less than 5% of that heat. ACEEE research has found that industrial IHPs can reduce the energy use associated with industrial process heat by up to 518 TBtus and enable CO₂e savings of between 30-43 million tons per year, which is equivalent to the emissions from 6.5–9.2 million gasoline-powered passenger vehicles driven for one year.¹

¹ <https://www.aceee.org/industrial-heat-pumps>

Several types of electrically powered IHPs that are commercially available today can deliver the high temperatures required to replace much of the fossil fuel-generated heat used in many industrial operations. In addition, IHPs can simultaneously meet process cooling needs. IHPs are also very often economical, with paybacks of under two years in some applications. Their viability will increase further with projected rising natural gas prices and declining electricity prices in most regions.

IHP products and their components are generally not being manufactured in the United States. As industrial companies look for the quickest and most cost-effective ways to decarbonize, it is essential that a robust, domestic IHP market be created and supported as soon as possible in order to ensure that those companies can easily replace long-lasting incumbent oil- and natural gas-fired boiler systems with heat pumps.

Funds from the DPA will be crucial to take full advantage of the near-term decarbonization potential of IHPs and to create equitable, long-lasting jobs in IHP manufacturing. Facilitated IHP manufacturing and deployment will ensure that U.S. manufacturing has the competitive edge over other countries also vying for limited heat pump manufacturing capacity, and that domestic IHP supply can be scaled to meet the need presented by the industrial and large commercial sectors.

Summary and Recommendations

In ACEEE's research and discussions with peers, IHPs have emerged as a key technology for decarbonizing industry through the electrification of carbon-intensive, fossil fuel-generated process heat. While regulatory and code concerns, as well as financial, economic, infrastructure, and behavioral barriers are slowing the proliferation and market adoption of IHPs, we focus our response on the hurdles to increasing IHP supply and manufacturing in the United States at the scale necessary to meet industrial process heating demand and near-term decarbonization potential.²

In general, we suggest that DPA funding can:

- Help create a robust, domestic IHP market supported by increased manufacturing of domestic heat pumps and heat pump components that will further
 - take advantage of the rapidly expanding IHP market potential
 - give domestic heat pump manufacturing a competitive edge
- Renovate and leverage existing industrial infrastructure to facilitate IHP production

² While scaling up use of residential and commercial heat pumps is also essential, and DPA funding would be helpful in those sectors as well, we note that the Inflation Reduction Act includes significant rebates and tax credits for residential heat pumps with no dedicated funds for industrial heat pumps.

- Create jobs for local workforces capable of supporting both this increased manufacturing and the implementation and technical support of IHPs in industrial processes
- Further environmental justice and equity in communities surrounding IHP manufacturers, engineers, and end-users

Responses to Questions

Category A: Open Solicitation

2. Electric Heat Pump DPA Solicitation: Based on what is described in the NOI, what are the potential positive and negative impacts of limiting the solicitation to projects that can commence production or manufacturing no later than December 31, 2025? What is the ideal length of time needed to get your project to first production?

New capacity for IHP manufacturing can certainly be brought online by the end of 2025. Timing is critical in efforts to accelerate the domestic manufacturing of IHPs. There is an immediate need to decarbonize industry and an immediate opportunity to electrify process heat through the use of heat pumps. It is essential that funds intended to support deployment of heat pumps do not ignore industrial applications. HVAC manufacturers need a consistent political environment and supportive policies to begin scaling up the U.S IHP market. Using DPA funds to jumpstart the transition to industrial heat pumps will help build a stable domestic supply, without which widespread adoption of IHP technology is impossible. Adding immediate capacity and production will ensure that the IHP market can reach an impactful scale as soon as possible. In certain industries, such as electric vehicle manufacturing, and semiconductor and computer chip manufacturing, where new facilities are being constructed, immediate electrification can help avoid the costly construction of natural gas supply infrastructure, and the long lifetimes of other fossil fuel assets. There is a significant need to deploy IHPs in a timely manner relative to customer construction.

3. Timeline: Based on what is described in the NOI, is there an ideal length of time that you believe will be required to prepare a proposal to DOE from the date the solicitation is announced?

The ideal length of time to respond would be approximately 120–150 days. Representatives of the industrial sector may need slightly longer to fully assess what challenges and needs exist in bringing the manufacturing of existing IHP designs to the

U.S (this assessment will include identifying necessary changes to meet regulatory and code requirements).

4. Award: Based on what is described in the NOI, do you believe award sizes of up to \$50 million of Federal funds (matched by the recipient) for activities to create or expand domestic industrial capabilities for electric heat pumps is sufficient? If not, what should be the appropriate maximum, and why? Should award maximums be different for each focus area for eligible project?

We believe that award sizes up to \$50 million of federal funds, to be matched by the recipient, are reasonable to jump start the key activities (see our response to Question #5 below). We recommend that the DPA funds be coordinated with other federal investments (see our response to Question #11) in industrial efficiency and decarbonization to provide greater support.

5. Award instrument: Based on what is described in the NOI, do you think financial assistance is the right DPA tool needed to support manufacturing of electric heat pumps? If not, please answer Question #12 below.

Financial assistance is a critical tool for supporting the domestic manufacturing and deployment of IHPs at scale. However, there are several additional barriers to overcome. These include regulatory issues with alternative refrigerants (such as ammonia and propane), the lack of existing district heating systems, certification constraints for IHP components (such as heat exchangers), and the lack of a qualified workforce. But the largest barrier is the lack of domestic supply capacity, and financial assistance through DPA funding is not only capable of but also essential for mitigating this fundamental barrier. The application of IHPs has immediate decarbonization potential that can only be seized by accelerating and expanding the manufacturing and implementation of heat pumps in industry, and for that, initial DPA funds are critical. The market demand for IHPs exists, but it must be enabled by a sustaining supply chain.

Funds should also be allocated to testing infrastructure, including independent test facilities to demonstrate and certify equipment performance, thus building consumer confidence and supporting commercialization.

6. Eligible projects: Based on what is described in the NOI, do you agree with the list of proposed projects that could be supported by DPA funding? If not, please provide reasons why for each of the proposed projects listed below. Please answer

Question 13 below for additional projects that you believe will be more relevant. The current list includes:

- a. New domestic production facilities projects including workforce investment; and**
- b. Renovation of existing production facilities projects, including workforce investment;**

Investment in developing the workforce is critical for expanding IHP manufacturing, installation, and successful integration into industrial processes. In conversations with representatives of IHP manufacturers, industrial facilities, and labor groups, workforce availability is continually emphasized as a significant barrier in pursuing industrial electrification and decarbonization as a whole. Industry needs an IHP market that is supported by well-known vendors with the workforce capacity to offer technical assistance and continuity of product support. Local engineering firms, whose expertise will be needed to assist industrial facilities with IHP implementation, also need better education about IHPs. Differences between domestically and internationally manufactured products exacerbate these knowledge gaps. Finally, technicians need additional training in the handling of high-pressure refrigerants. Federal funds should be specifically earmarked for workforce support at the IHP manufacturing level in the United States.

In terms of renovation of existing production facilities, the expansion of existing HVAC manufacturers to include IHP manufacturing capacity will be the most successful approach to expanding production. This is primarily due to the time required to construct new facilities. Considering both DPA's time frame and the window of opportunity for expanding immediate, cost-effective electrification to decarbonize industrial process heat, it will be easier to alter HVAC vapor compression manufacturers to accommodate IHP manufacturing than it would be to repurpose facilities currently manufacturing fossil fuel-based equipment.

7. Project Selection criteria: Based on what is described in the NOI, do you agree with the list of selection criteria that would be used to qualify projects for electric heat pump DPA funding? Please list selection criteria that you believe may limit the expansion of electric heat pump manufacturing and why. What additional criteria/requirements/procedures should the government consider for selecting qualifying projects, and why?

Broadly, the list of selection criteria makes sense for qualifying projects for electric heat pump DPA funding. However, it is important that the selection criteria be prioritized, as requiring applicants to meet all qualifications may limit manufacturing potential.

Qualification four, the degree to which manufactured products can meet Build America, Buy America Act requirements, may be a limiting factor, as key, costly components of industrial heat pumps will need to be imported until domestic manufacturing and a domestic market are established, which may require several years, particularly considering the workforce availability challenges discussed in our response to Question #6. Key IHP components on which domestic manufacturing should be focused are included in the response to Question #22.

The extent of reduction in energy use, cost, fossil fuels, and GHG emissions (qualification 5.b) should also consider including the additional benefits of energy efficiency, other non-energy benefits (including water savings, pollutant reductions, others), and how IHPs can enable further savings in these areas in combination with other technologies and approaches, including demand response, and thermal storage, among others.

8. Project Selection criteria: When considering selection criteria, how should DOE evaluate eligible projects that meet several criteria? What additional information should DOE seek from applicants and include in evaluation to help simplify this evaluation process? What metrics and methods are available for conducting such evaluations?

See previous question.

9. Program structure: Is there anything else to be aware of as DOE designs potential implementation of electric heat pump DPA funding to support U.S manufacturers, developers and installers?

One important barrier to recognize is that much of the existing IHP intellectual property is not currently owned in the U.S. It is critical to (1) bring internationally available technology to the U.S. and (2) enable domestic companies to manufacture their products in order to create a vibrant heat pumps marketplace.

Category B: Domestic Manufacturing, Including Small and Medium Sized Manufacturers (SMM)

10. How do you anticipate the U.S. market for heat pumps will grow in the coming years? In what segment (commercial, residential, industrial) do you anticipate the greatest challenges to meeting new demand?

Industrial energy users are growing increasingly interested in decarbonization. This interest is reflected in the number of power purchase agreements for carbon-free electricity that have been made in the industrial sector. Now, many companies are looking to go further. Prominent players from across the economy and from every industry are participating in steps to reach lower-carbon futures. The Science Based Targets Initiative, for example, maintains a list of industrial firms that have made commitments to that end. However, there have been limited pathways to decarbonize much of process heating, which is responsible for approximately 38% of onsite manufacturing emissions, because of the high temperatures needed by industrial processes. Industrial heat pumps are the most immediate and efficient energy-savings technology for electrifying and decarbonizing process heat. Because of the momentum towards decarbonization, coupled with the current carbon intensity of process heat across industrial sectors, and the increasing ability of IHPs to satisfy even higher temperature heat requirements, we foresee significant growth potential in the IHP market in the next few years. We anticipate a potential sales opportunity in excess of \$17 billion, and over \$5.6 billion per year in energy cost savings from electrifying just the near-term applications in the chemicals, food and beverage, and pulp and paper sectors. There is also little awareness of the potential for IHPs at the end-user level. As heat pumps receive more attention, funding, and focus, demand will surely increase. Additional heat pump analysis can be found in ACEEE's IHP research.³

Despite this potential, we also expect that the greatest challenges to meeting heat pump demand in the industrial sector will occur for the following reasons:

- Many heat pumps able to meet the temperature requirements of industrial processes are only commercially available internationally
- There are code and regulatory constraints on importing foreign IHP systems and components
- There are workforce constraints on manufacturing, implementation, and technical assistance for integration in diverse industrial processes
- There is a need for testing infrastructure to demonstrate and certify the larger capacities and higher temperatures for many IHPs

³ <https://www.aceee.org/industrial-heat-pumps>

- There is a need to demonstrate the market demand for IHPs to justify manufacturers' investments in domestic capacity

We consider DPA funding to be an important step for mitigating these barriers and building up a domestic IHP manufacturing capacity that will be critical for electrifying industrial process heat and achieving meaningful energy and emissions savings.

11. How much new/retooled capacity is needed to ensure domestic production meets new domestic demand expected from new Inflation Reduction Act funding? Please account for the impacts of the Inflation Reduction Act.

We anticipate that momentum in the growing IHP market will continue to accelerate, driven in part by Inflation Reduction Act (IRA) funding. The Advanced Industrial Facilities Deployment Program provides over \$5.8 billion for the purchase, installation, and implementation of technologies that (among other options), achieve emissions reductions through the electrification of heating processes, such as industrial heat pumps. The program also will provide funds for retrofits and engineering studies needed to prepare eligible facilities. Other programs, including DOE's Industrial Heat Shot,⁴ and the expansion of the 48C manufacturers' tax credit in the Inflation Reduction Act,⁵ are also stoking demand among end-users. There is already growing interest from industry in connecting with DOE and other funding vehicles to implement IHPs. This demand needs to be accommodated by domestic production and supply at scale.

We expect demand to be driven by carbon-intensive industrial sectors with large, low to-medium temperature process heat requirements, including chemicals, food and beverage, pulp and paper, and others. These sectors represent billions of dollars added to the economy at thousands of facilities that employ millions of Americans. These high-potential use sectors could drive IHP demand into the billions of dollars in order to further decarbonization, efficiency, and energy and cost savings, especially as they look to connect with IRA, BIL and other funding opportunities.

⁴ DOE's Industrial Heat Shot aims to develop industrial heat decarbonization technologies with at least 85% lower GHG emissions by 2035. <https://www.energy.gov/eere/industrial-heat-shot>

⁵ The IRA expanded section 48C to provide \$10 billion in tax credits for manufacturers to construct specified clean energy projects, including manufacture of energy conservation technologies and reduction in plant GHG emissions. The tax credit is 30% of the amount invested in new or upgraded facilities

12. List the greatest barriers (e.g., financing or market constraints) that DPA tools described in

the background can help address in the following areas:

a. U.S. manufacturing of electric heat pumps:

b. Deployment of electric heat pumps:

a): The greatest barriers for U.S. manufacturing of heat pumps include:

- Workforce limitations
- Intellectual property constraints on IHP components
- Codes and regulatory constraints, including for non-ASME pressure vessels, piping, and heat exchangers

b): The greatest barriers for deployment of electric heat pumps include:

- Engineering limitations for supporting IHP implementation and integration
- Lack of test sites
- Lack of current domestic supply of IHP components
- Lack of market awareness
- Informational barriers in regard to IHP savings potential, and of domestic suppliers
- Need for maintenance infrastructure (continually renewed supply of IHP components to the areas in which IHPs are deployed)

13. Which DPA tool(s) and contracting vehicles would best help address the barriers identified in Question 12 above, to strengthen U.S supply chains: purchases, purchase commitments, financial assistance, subsidy payments, or other (e.g., use of Other Transactions Authority or a Partnership Intermediary Agreement)?

ACEEE considers Other Transaction Authorities (OTAs) to represent an important contracting vehicle for advancing impactful technologies for industrial decarbonization, including potential DPA funds for IHPs. OTAs have been successfully used by agencies including the DOD and NASA to speed up procurement and contracting of important technologies. OTAs can operate as key mechanisms to lower transactional friction and barriers and promote the commercialization of nascent technologies that are commercially valuable to the industrial sector but need to be produced rapidly and at

scale, such as industrial heat pumps. Additional OTA and other funding mechanism information can be found in ACEEE’s report on program design at DOE.⁶

20. What are barriers to designing, manufacturing, and using refrigerants with low global warming potential (GWP) in electric heat pumps? What are potential interactions with new equipment efficiency standards and Inflation Reduction Act incentives?

Current refrigeration regulations in the United States allow for refrigerants with GWPs as high as 750 over a 100-year timescale, whereas in Europe, regulations have focused on enabling only natural refrigerants or HFOs (hydrofluoroolefins), which typically have GWPs that are less than 10 over a 100-year timescale. Future policy and standards changes, while outside the scope of possibility with DPA funds, would be the best mechanism to alter these regulations and market constraints and avoid forcing domestic refrigerant manufacturing and use towards higher GWPs through the use of HFCs (hydrofluorocarbons).

C. American Workforce Investment

22. What workforce training programs or partnerships (for instance, employer/community college/labor consortia, on-the-job training, private sector training providers, sector strategies) do you think will be useful to support creation of workforce need for electric heat pump manufacturing and installation? What unions, worker groups, economic development centers, professional societies, community-based organizations, (post)secondary education facilities, and other stakeholders could be valuable partners in these training activities? Please fill out the chart below and add rows as needed.

Electric heat pump project	Labor skills needed	Training programs/ partnerships to address need	Key Partners
Manufacturing of critical IHP components, including: <ul style="list-style-type: none"> • Refrigerants 	<ul style="list-style-type: none"> • Maintenance • Handling • Process Integration • Engineering 	<ul style="list-style-type: none"> • Industrial Assessment Centers on the engineering, 	<ul style="list-style-type: none"> • NSF Community Colleges Initiative

⁶ https://www.aceee.org/sites/default/files/pdfs/reimagining_program_design_at_doe_final.pdf

<ul style="list-style-type: none"> • Heat exchangers • Compressors 	<ul style="list-style-type: none"> • Thermal analyses • Manufacturing • Installation 	<p>implementation side</p> <ul style="list-style-type: none"> • Plant-level apprenticeship programs 	<ul style="list-style-type: none"> • DOE’s Industrial Assessment Centers • Utilities • State Energy Offices • National Institute of Standards and Technology’s Manufacturing Extension Partnerships
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D. Energy and Environmental Justice, and Economic Benefit

25. Which project types should electric heat pump DPA funding prioritize to assist underserved and underrepresented individuals and communities around the United States in obtaining the benefits of electric heat pumps? What criteria should DOE use to select these projects? Please fill out the chart below and add rows for multiple entries as needed.

Industrial facilities, including prospective IHP manufacturing facilities, are often located in historically underserved, lower income communities. ACEEE supports hiring from within communities where facilities are located, especially as new, high potential, low-carbon-enabling jobs are created. Funding for IHP manufacturing and IHP implementation should also prioritize retraining and reskilling of workers whose jobs may be phased out in low income, underserved communities.

It is important to note that beneficial electrification of industrial plants increases environmental quality by reducing emissions and pollutants through the reduced burning of fossil fuels and the use of fossil fuel-backed infrastructure. DPA funding should prioritize electrifying industrial facilities in low income, underserved communities, in consultation with those communities, in order to ensure these benefits accrue to those most affected.

27. How can electric heat pump DPA funding encourage reuse/leverage existing industrial infrastructure?

We anticipate that most potential IHP manufacturing facilities will be located on or adjacent to existing HVAC manufacturing facilities.